Design Flexibility in Arterial Highway Design

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Overview of Presentation

- Framing the context of urban arterials
- Notions of Safety
- Design Standards
- Risk Assessment and Management

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Fundamental Objectives of Highway Planning and Design in the Urban Environment

- Reflecting Community Values
- Achieving Environmental Sensitivity
- Ensuring Safe and Feasible Solutions

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An acceptable solution reflects community values

SWG Meetings

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What are the Community's Values?

- Safety (of motorists and pedestrians)
- Mobility (both local users and 'through" users)
- "Livability"
- Economic redevelopment
- Creation of "pedestrian friendly" environment

How do these values change from community to community?
How and where do they conflict with each other?

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Finding an acceptable solution sometimes means balancing community values that sometimes conflict with each other

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An important insight for addressing community values as part of design -- *Designers (and stakeholders) have choices*

- Traffic Operational Parameters
  - –Design Traffic
  - –Design Level of Service
- Geometric Design Inputs
  - –Design Speed
  - –Design Vehicles

CSD means making choices that reflect community values

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For example -- Guidelines for Design Levels of Service (per AASHTO) are just that -- *Guidelines*

Design LOS is a choice that involves trade-offs

- –Better LOS means
  - *larger 'footprint'*
  - *improved safety (sometimes)*
- –Lower LOS
  - *lesser R/W and other physical impacts*
  - *more operation under congestion*
  - *potentially adverse economic effects*

Highway Type	Type of Area and Appropriate Level of Service			
	Rural Level	Rural Rolling	Rural Mountainous	Urban and Suburban
Freeway	B	B	C	C
Arterial	B	B	C	C
Collector	C	C	D	D
Local	D	D	D	D

NOTE: General operating conditions for levels of service (Source: Ref. 11):
A - free flow, with low volumes and high speeds.
B - reasonably free flow, but speeds beginning to be restricted by traffic conditions.
C - in stable flow zone, but most drivers restricted in freedom to select their own speed.
D - approaching unstable flow, drivers have little freedom to maneuver.
E - unstable flow, may be short stoppages.

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Another example -- acceptable levels of congestion vary by location and project

Project teams have choices concerning traffic

- –Design Year Traffic
  - *Traffic Volumes*
  - *Traffic Patterns*
  - *Vehicle Types*
- –Level of Service

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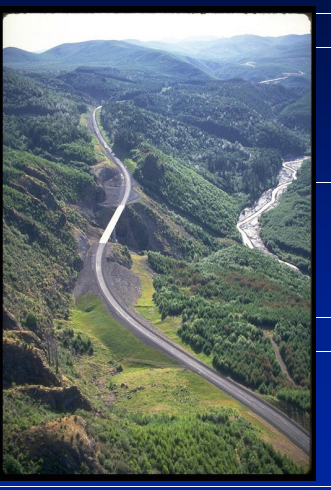
Perhaps the most important choice -- Design Speed

- **Controls the design of most geometric elements**
  - –operational and safety implications
  - –cost, right-of-way implications
- **Should be established for long segments of a route**
- ***Represents a choice by the designer***



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Design choices and their safety implications

- **Design Speed** → More rigorous alignment and roadside requirements (may affect feasibility of alternative concept)
- **Design traffic and level of service** → Greater density or congestion will produce greater risk of multi-vehicle conflicts; more passing, etc.
- **Design vehicle** → Longer vehicles require larger intersections; may increase risk to pedestrians

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Our customers value safety -- but how do they define it?

- **Perceived safety**
  - –based on personal driving and walking experiences
  - –comfort or discomfort (with traffic, conditions, a site, etc.)
  - –lower speeds are safer; faster speeds are dangerous

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A highway engineer's "model" for safety

= Safe Design Practices

= ?

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Is this road 'safe' or 'unsafe'?

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Two Ways to Look at Safety* as Highway Engineers and Planners; and as Community Stakeholders

- ***Nominal Safety*** is examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures
- ***Substantive Safety*** is the expected crash frequency and severity for a highway or roadway

Ezra Hauer, ITE Traffic Safety Toolbox Introduction, 1999

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Nominal Safety

Three aspects of nominal safety

- **Roadway design must enable road users to behave legally**
- **Roadway design should not create situations with which a minority of road users has difficulties**
- **Owning agency requires protection against claims of moral, professional and legal liability**

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Substantive Safety

Substantive safety is the *performance of the road* as measured in terms of crashes, including their frequency, type and severity.

- **A function of what resources are available (roadway design, maintenance, enforcement, emergency medical services)**
- **A function of the "context" of the location**

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A suggested framework for considering safety on urban arterials

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Substantive Safety Varies Significantly by Type of Road, Location and Other Factors

Representative Accident Rates by Location and Type of Road

	Fatal Accidents	Injury Accidents	Total Accidents
RURAL	Number per MVM	Number per MVM	Number per MVM
2 Lanes	0.07	0.94	2.39
4 or more lanes, divided subtotal	0.063	0.77	2.09
Freeway	0.025	0.27	0.79
URBAN			
2 Lanes	0.045	1.51	4.94
4 or more lanes, undivided	0.04	2.12	6.65
4 or more lanes, divided	0.027	1.65	4.86
Freeway	0.012	0.4	1.43

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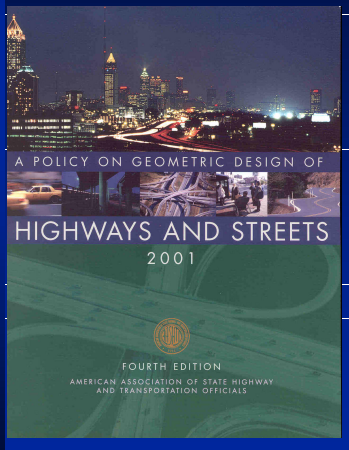
Application of Established Design Criteria ('Nominal Safety') is the Basis for Achieving Substantive Safety



- AASHTO Policy values reflect many considerations
  - –Safety
  - –Costs
  - –Traffic Operations
  - –Maintenance
  - –Constructability

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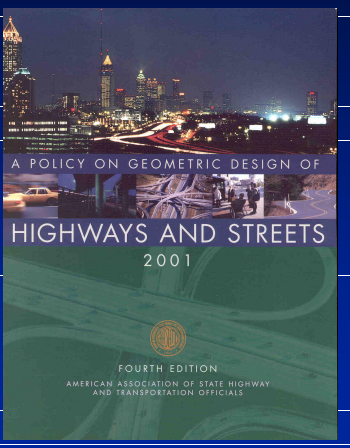
Terminology



- WashDOT establishes standards
- The AASHTO Policy is a Guide (not a standard)
- Avoid referring to 'safety standards'

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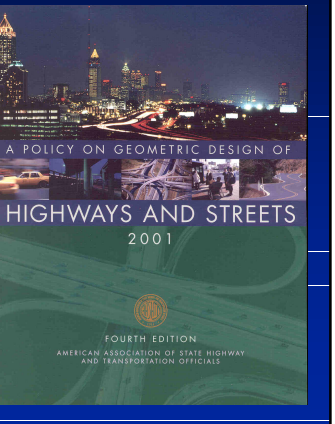
The AASHTO Policy is a flexible document; the intent is it be used flexibly and responsibly

- Flexibility
  - –The design process includes choices
  - –AASHTO criteria are flexible
- Responsibility
  - –Choices should be reasonable and consistent
  - –Choices should reflect purpose and need



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A relevant example of flexibility in the AASHTO Policy -- Roadside

The AASHTO Roadside Design Guide is just that -- *a Guide*

"While clear zone dimensions are provided in the AASHTO Roadside Design Guide, they should not be viewed as either absolute or precise" (AASHTO Task Force on Roadside Safety; for AASHTO's Bridging Document)

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Roadside Design in the Urban Environment

- The notion of a 'clear zone' is recognized as being impractical
- Offset or clear dimensions reflect operational versus substantive safety issues
- Roadside objects represent real, substantive hazards

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What is the "context" of our arterials?

- Adjacent Land Uses
- Terrain and topography
- Access (intersections and driveways)
- Pedestrian activities (where?)
- Available right-of-way

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Geometric design elements that control the safety and operation of a highway according to the FHWA

- Lane width
- Shoulder width
- Normal cross slope
- Horizontal curvature and superelevation
- Superelevation transition
- Tangent grade
- Vertical curvature
- Vertical clearance
- Stopping sight distance
- Bridge width
- Horizontal clearance*
- Structural capacity

*This is not "clear zone"

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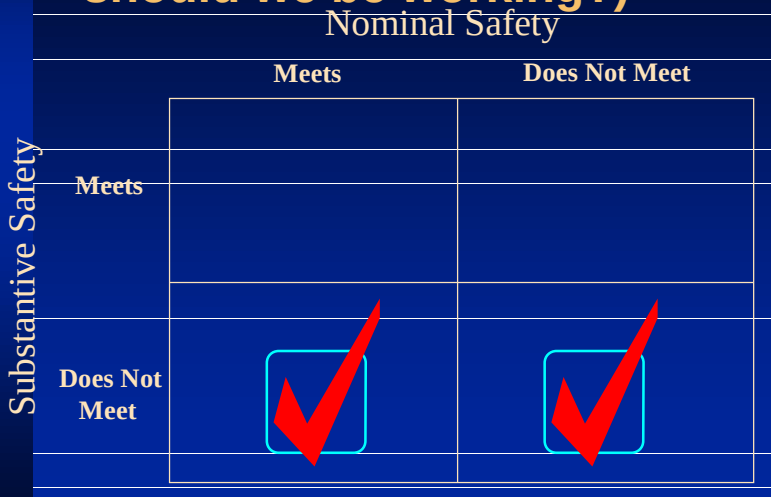
Where should we focus our efforts (in which quadrants should we be working?)



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Challenges we must overcome

- What constitutes acceptable safety performance (in quantitative terms)?
- How can we understand, accept and manage the 'risk' of decisions we expect will adversely affect safety performance

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A critical insight in understanding design criteria and safety -- *"Safety" is not an absolute, but a continuum*

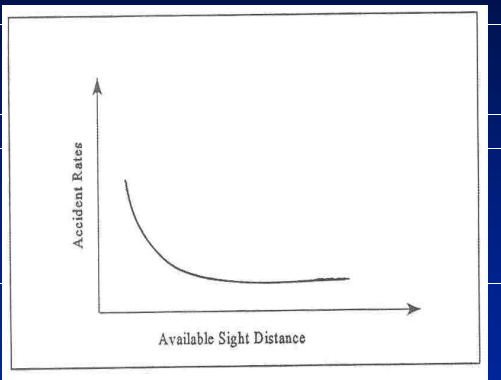

Figure 4. Conceptual Relationship Between Available Sight Distance and Safety at Crest Vertical Curves

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What do we know about the substantive safety (frequency and severity) of urban arterials?

- Access Control
  - –Type of median
  - –Frequency of driveways
  - –Frequency of intersections
- Signalized Intersections
- Pedestrians

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What do we know about the substantive safety of roadsides in the urban environment?

- Frequency and severity of crashes with roadside objects
  - Highway types
  - Speeds
  - Contributing factors
- Redirective capabilities of curbs

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Determining the Substantive Safety of Design Alternatives for Urban Arterials

- Characterize and understand current safety performance
- Employ 'Best Practices' (crash prediction models, synthesis of research)
  - Harwood (NCHRP 282)
  - McCoy and others (Bayesian)
  - Zegeer re: pedestrians
  - ROADSIDE and/or RSAP
  - Zegeer utility pole, fixed object collision models
- Exercise engineering judgment in interpretation

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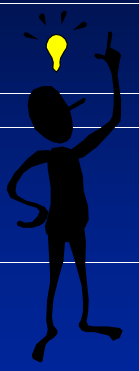
Insights we need to make good 'substantive safety' decisions

- What are the characteristics of crashes (including pedestrian-involved) on arterials?
  - –Types
  - –Severity
  - –Environmental factors
- How do our design decisions influence these (both + and -)?
- What other opportunities to address these do we have?



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Different Project Types Affect Approaches to Achieving Substantive Safety

- Existing Highway
  - –3R Projects
  - –Hazard Elimination
  - –Reconstruction

→ Existing Knowledge Base
  - –Traffic (volume and operations)
  - –Crash frequency, location, severity

- New Corridor

→ Limited Knowledge Base
  - –Traffic Forecast
  - –No crash history

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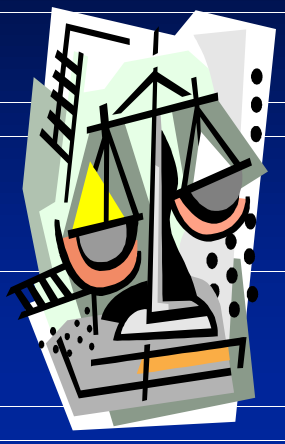
Tort Liability and Design Decision-making

- Sovereign Immunity
- Discretionary vs Ministerial Functions
- Design exceptions and tort risk
- Client perceptions of risk



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Sovereign Immunity

- Very few states retain immunity from lawsuits (WI is one)
- Loss of sovereign immunity pre-dates CSD
  - Congress acted in 1946
  - Individual states acted in 1950s and 1960s
- Tort claims began to be a problem in 1970s and 1980s

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Necessary elements of a successful tort claim

- Did damages occur?
- Did a potentially dangerous defect exist?
- Was the defect a proximate cause of the damages?
- Did the agency have knowledge of the defect?
- Was the agency acting in a discretionary or ministerial role?
- Did the plaintiff contribute to the damages through negligent behavior

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An important distinction -- ministerial vs. discretionary functions

- Ministerial functions -- clearly defined tasks or responsibilities entailing little personal judgment (e.g., highway maintenance)
- Discretionary functions -- involves decisions requiring judgments by professionals

While state laws vary, most states consider discretionary functions immune from tort claims

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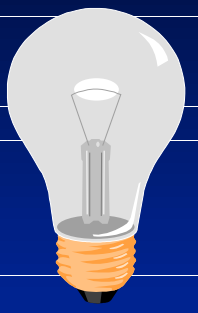
Design decisions and tort risk



In most jurisdictions, the activities associated with the design process represent *discretionary functions*

- –Actions must be reasonable (i.e., not arbitrary)
- –Actions and decisions should be documented

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Myths, fears and legitimate concerns

• Myth	• Reality
–Knowledge of a substandard ('nominal') highway exposes an agency to a suit	–Courts do not expect agencies have the resources or ability to 'upgrade' every highway to full standards
–Identifying 'high accident' locations and then not addressing them exposes an agency to a suit	–Defense of a claim will hinge on an agency's ability to demonstrate a program of priorities
–Accepting design exceptions exposes an agency to a suit	–Lack of documentation (not the presence of the exception per se) exposes the agency

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Tim Neuman's Opinions on CSD and Tort Risk

Good context sensitive practices (consider alternatives, weigh trade-offs, design using good industry practices, make and explain decisions openly, and document fully all aspects of the project) represent good risk management practices.

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More Opinions

- The best approach is to adhere to design criteria (one can be creative within the Policy)
  - Be thoughtful and careful in establishing design criteria (especially design speed)
  - Understand safety implications (they vary) for all decisions (even those not involving design exceptions)
  - Develop and consider alternatives; document fully important design decisions

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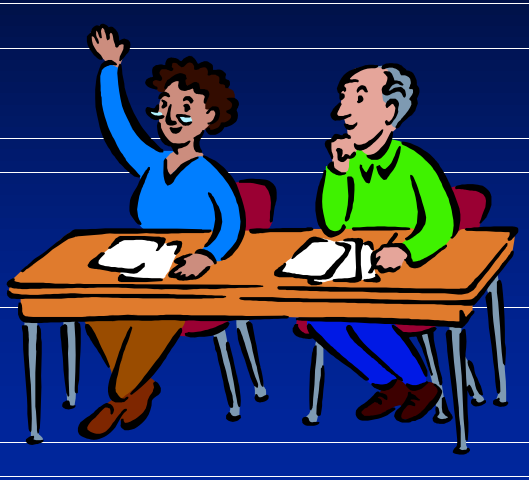
Questions and Discussion



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